(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 126 300 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 158(3) EPC

(43) Date of publication:
22.08.2001 Bulletin 2001/34

(21) Application number: 00907941.9

(22) Date of filing: 08.03.2000

(51) Int Cl.7: G02B 23/16, G02B 7/183, B64G 1/66, H01Q 1/12, H01Q 1/28, H01Q 3/08

(86) International application number:
PCT/JP00/01395

(87) International publication number:
WO 00/54088 (14.09.2000 Gazette 2000/37)

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE

(30) Priority: 10.03.1999 JP 6345099
10.03.1999 JP 6344999
25.08.1999 JP 23830099

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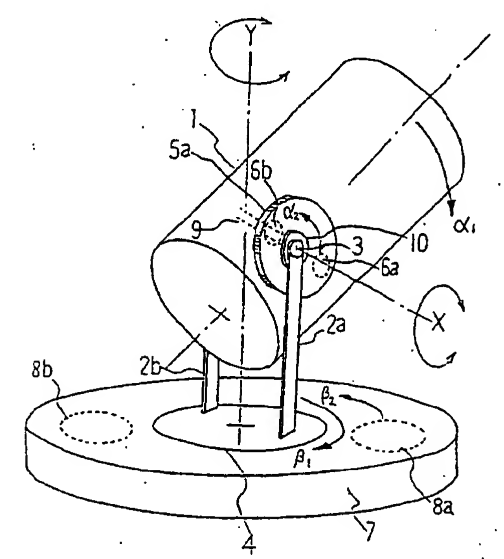
(54) TELESCOPE AND MOVEMENT CONTROL DEVICE

(57) Telescope is constructed so that inertia force caused when the telescope is moved is canceled to thereby eliminate influences given on a space station, artificial satellite or the like. When a telescope body (1) rotates around an axis (X) to a direction (α_1), counter weights (6a, 6b) are driven by a rotator drive (10) rotationally to a direction (α_2), which is reverse to the direction (α_1), and the inertia force caused is canceled. Also, when the telescope body (1) rotates around an axis (Y) to a direction (β_1), counter weights 8a, 8b are rotated to a direction (β_2), which is reverse to the direction (β_1), and the inertia force caused is canceled.

Further, an equipment movement control device for moving an equipment to a desired position and a telescope which is able to converge a full quantity of light entering a telescope body to a condenser are disclosed.

Fig. 1



EP 1 126 300 A1

Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a device, such as a telescope or antenna, which needs a directional control for a tracking purpose, said device being weighty itself and yet installed on a structure, such as that installed in the space, on board ship or on land, existing in a place where occurrence of reaction force or inertia force is unfavorable. Especially, in case where a telescope, for example, is installed on a space station or artificial satellite, if the telescope is moved, a large inertia force arises to act on the space station and an attitude control of the station itself is badly affected. Hence, such a telescope as structured to cause no such inertia force and to be operated accurately in the space, on board ship or on land is provided.

Description of the Prior Art

[0002] When a large type astronomical telescope, such as Hubble's space telescope, in the prior art is to be directed to an object to be observed, it is moved in its entirety, which requires a large energy. Especially, in the case of a telescope launched to be operated in the space, although not illustrated, a reflecting telescope is assembled in a satellite unit and this satellite unit itself must be attitude-controlled so as to direct the telescope to the object to be observed. Such attitude control of the telescope is done by performing an attitude control of a satellite unit mounted with a CMG (Control Moment Gyro) or by performing a position control of a satellite unit by gas jetting. Thus, only for the purpose to move the space telescope, a large energy is needed. Also, when a telescope installed on a space station is operated, a large inertia force arises, which is not allowable in the space station. Hence, such a structure as causes no such inertia force, even when the telescope is moved to be directed to the object, has been long desired. Further, when the device, such as an antenna or the like, is to be directed to the object, reaction force by the CMG or the like is used like in the case of the telescope.

[0003] In the prior art space telescope, as mentioned above, the telescope is assembled in the satellite and when the telescope is to be directed to the object, the satellite unit itself is attitude-controlled. In order to move the telescope, therefore, a large scale structure and a large energy are required. Hence, development of a telescope having such a structure as is simple and yet is attitude-controllable accurately has been desired. Also, when the telescope installed on a space station is operated, then a large inertia force arises to act on the space station to thereby cause a large problem on the attitude control of the space station itself. But, occurrence of such inertia force being not allowable in the space station, development of a telescope which is to be used on a space station and yet has such a structure as causes no such inertia force has been likewise desired.

[0004] Fig. 20 is a constructional view of a large type astronomical reflecting telescope in the prior art. In Fig. 20, numeral 221 designates a telescope body. A concave mirror 222 is provided in a lower part of the telescope body 221 and a condenser 223 is provided in an upper central part of same. In a central part of the concave mirror 222, there is bored a hole 225 passing therethrough. A camera or an ocular 224 is provided right below the hole 225.

[0005] In the astronomical telescope constructed as above, light or ray 230 coming from the space enters the telescope body 221 through its upper portion to be reflected by the concave mirror 223, like numeral 230a, then to be converged by the condenser 223, like numeral 230b. The light so converged by the condenser 223 passes through the hole 225 provided in the central part of the concave mirror 222 and is converged to the camera 224 to be taken as an image. In the reflecting telescope so constructed, the light 230 entering the upper portion of the telescope body 221 is blocked partially by the condenser 223 provided in the central portion of the telescope body 221, so that the light coming to the concave mirror 222 is reduced in the quantity and converging ability as a whole is lowered. Thus, an improvement to take a further accurate image has been also desired.

SUMMARY OF THE INVENTION

[0006] In view of the problems in the prior art, the present invention is made with the following objects:

(a) To provide a telescope having such a structure as to cancel the inertia force generated when the telescope is operated to be directed to an object to thereby become usable in the space without occurrence of the inertia force even if the telescope is installed on a space station,
(b) To provide an equipment movement control device having a simple structure by which an equipment, such as a telescope or antenna, is moved to be directed to an object and yet is moved accurately to a given direction, and
(c) To provide an astronomical reflecting telescope having a condenser structure in which a condenser is so arranged that an entering light may not blocked by the condenser to thereby enhance a whole converging ability.

[0007] In order to attain the object mentioned in (a) above, the present invention provides means of the following (1) to (10):

(1) A telescope comprising a telescope body and a reflecting mirror, a condenser and a camera or ocular contained in the telescope body, characterized

in further comprising a counter weight that moves rotationally at the same time when the telescope body is moved rotationally to be directed to an observation object so that inertia force caused by the rotational movement of the telescope body may be canceled.

(2) A telescope comprising a telescope body and a reflecting mirror, a condenser and a camera or ocular contained in the telescope body, characterized in that the reflecting mirror, condenser and camera or ocular are connected integrally to one another so that the reflecting mirror is movable together with the condenser and camera or ocular to be directed to an observation object.

(3) A telescope comprising a telescope body and a reflecting mirror, a condenser and a camera or ocular contained in the telescope body, characterized in that the reflecting mirror and a unit of the condenser and camera or ocular are movable independently of each other.

(4) A telescope as mentioned in (2) or (3) above, characterized in that a plurality of counter weights are fitted to a circumferential periphery of a bottom portion of the reflecting mirror.

(5) A telescope as mentioned in (2) or (3) above, characterized in that a plurality of counter weights are fitted to a circumferential periphery of a base portion to which the reflecting mirror is fitted.

(6) A telescope as mentioned in (2) or (3) above, characterized in that a counter weight is provided between the reflecting mirror and a base portion to which the reflecting mirror is fitted so that a bottom surface of the reflecting mirror and the base portion are connected to each other and the counter weight is movable in a direction reverse to a movement of the reflecting mirror.

(7) A telescope as mentioned in (4) or (5) above, characterized in that each of the counter weights is fitted via an actuator.

(8) A telescope as mentioned in (5) or (6) above, characterized in that a plurality of horizontal component counter weights are arranged on an upper surface of the base portion.

(9) A telescope as mentioned in (1) above, characterized in that the counter weight comprises a counter weight for canceling the inertia force caused when an end of the telescope body inclines toward the observation object to move up and down rotationally and a counter weight for canceling the inertia force caused when the telescope body, so inclining, rotates around an axis orthogonal to a base portion to which the telescope body is fitted.

(10) A telescope as mentioned in (9) above, characterized in that the counter weight for canceling the inertia force caused when the end of the telescope body moves up and down rotationally is fitted to an end of an arm and the arm is constructed to be rotatable.

That is, if the telescope is rotated to be directed to an observation object, such as a star, a large inertia force occurs. Especially, when the telescope is installed on a space station, this inertia force acts on the station side to give serious influences on the microgravity environment. Hence, occurrence of such inertia force is not allowable. In the invention (1) above, such inertia force is canceled by the reverse directional force caused by the counter weight and hence the telescope of the present invention is well applicable to the space station. Also, as mentioned in the invention (9) above, the counter weight comprises two types thereof to cancel the inertia force caused by the upward and downward rotational movement of the end of the telescope and to cancel the inertia force caused by the rotation of the telescope body around the axis orthogonal to the base portion and hence the inertia forces so caused can be canceled effectively.

In the invention (2) above, the reflecting mirror, condenser and camera or ocular are constructed to be moved integrally for tracking stars, etc. and also in the invention (3) above, the reflecting mirror and the unit of the condenser and camera or ocular are constructed to be moved independently of each other, and whichever of these constructions is employed, there is no need to move the entire telescope body for tracking the observation object and hence the movable portions can be reduced.

In the inventions (4) and (5) above, the plurality of counter weights are fitted so as to cancel the inertia force which occurs corresponding to the movement of the reflecting mirror and, in addition to the effect of the inventions (2) and (3) above to reduce the movable portions, the inertia force of such movable portion can be also canceled. Further, as mentioned in the inventions (6) and (7) above, the fitting art of the counter weight is uniquely devised so as to enlarge the application range and also in the invention (8) above, the horizontal component counter weights are added and thereby the inertia force can be canceled securely.

Also, in order to attain the object mentioned in (b) above, the present invention provides means of the following (11) to (13):

(11) An equipment movement control device for moving an equipment body to be directed to an object, characterized in comprising an equipment body having its bottom surface formed in a curved shape; an equipment body basement supporting a bottom poction of the equipment body and having its bottom surface made of a magnetic substance and formed in a curved shape complementary to the curved shape of the bottom surface of the equipment body; a base stand having its upper surface formed in a curved shape complementary to the curved shape of the bottom surface of the equipment body basement so that the bottom surface of

the equipment body basement may abut on the upper surface of the base stand levitatably therefrom; a plurality of stationary side coils arranged on an entire portion of the upper surface of the base stand; a plurality of moving purpose coils arranged in radial directions extending from a center of the upper surface of the base stand; and a control means for exciting the stationary side coils and moving purpose coils so as to levitate the equipment body basement from the base stand and to control a movement of the equipment body basement.

(12) An equipment movement control device as mentioned in (11) above, characterized in that the equipment body is a telescope body that comprises a reflecting mirror formed in a curved shape on a bottom surface of the telescope body, a condenser arranged in an upper portion of the telescope body and a camera or ocular supported right below the condenser, or the equipment body is an antenna body that comprises an antenna erecting at a central portion of the antenna body and has its bottom surface formed in a curved shape.

(13) An equipment movement control device as mentioned in (11) or (12) above, characterized in that the base stand has a space formed therein having a curved shape complementary to the curved shape of the upper surface of the base stand and having a constant height of the space; a counter weight, having its bottom surface made of a magnetic substance, is placed movably in the space; a plurality of stationary side coils are arranged on an entire portion of a bottom surface of the space; a plurality of moving purpose coils are arranged in radial directions extending from a center of the bottom surface of the space; and the control means controls excitement of the stationary side coils and moving purpose coils so that both of the coils may be excited simultaneously to thereby levitate the counter weight from the bottom surface of the space and to move the counter weight to a direction reverse to the movement of the equipment body basement.

That is, the invention (11) above is applicable to the equipment movement control device and the invention (12) above is applicable to the telescope or antenna movement control device. In the inventions (11) and (12), once the control means excites the stationary side coils arranged on the upper surface of the base stand, the equipment body is magnetically levitated from the upper surface of the base stand by the repulsive force between the magnetic substance of the equipment body basement and the stationary side coils. Then, the control means excites the moving purpose coils arranged at the location to which the equipment body is to be moved out of the plurality of the moving purpose coils and the equipment body, while being levitated, is easily moved to the desired location by the attractive force between the magnetic substance of the bottom surface of the equipment body basement and the moving purpose coils so excited. When the equipment body moves to the desired location, the control means releases the excitement of the stationary side coils and thereby the equipment body basement abuts on the upper surface of the base stand to be fixed there. Thus, the observation object can be observed at the position so set.

In the invention (13) above, at the same time when the equipment body moves as mentioned above, the counter weight is moved in the direction reverse to the moving direction of the equipment body and thereby the inertia force caused by the movement of the equipment body is canceled. That is, the control means excites the stationary side coils of the bottom surface of the space of the base stand to thereby levitate the counter weight from the bottom surface of the space by the repulsive force between the magnetic substance of the counter weight and the stationary side coils. At the same time, the control means excites the moving purpose coils of the bottom surface of the space arranged at the location opposite to the location to which the equipment body is to be moved to thereby move the counter weight reversely to the equipment body by the attractive force. Thus, the inertia force caused can be canceled.

When the telescope is moved rotationally to be directed to an observation object, such as a star, or the antenna is moved, then a large inertia force arises. Especially, if the telescope or antenna is installed on a space station, this inertia force adds to the station side to give serious influences in the microgravity environment and hence occurrence of such inertia force is not allowable. According to the invention (13), such inertia force is canceled by the force of the counter weight acting in the reverse direction and the mentioned equipment movement control device can be applied to the space station as well.

Further, in order to attain the object mentioned in (c) above, the present invention provides means of the following (14) to (16):

(14) A reflecting telescope comprising a telescope body of a cylindrical shape, a concave mirror arrangement on a bottom surface of the telescope body, a condenser arranged above the concave mirror and a camera or ocular arranged below the condenser and being constructed such that light entering an upper portion of the telescope body is reflected by the concave mirror to be converged to the condenser and further to the camera or ocular, characterized in that the concave mirror is made so as to make an angle of the light so reflected adjustable by an actuator; an opening portion is formed in a middle portion of a side wall of the telescope body; the condenser is located outside of the opening por-

tion so that a full quantity of the light so entering the upper portion of the telescope body may be reflected by the concave mirror and received by the condenser through the opening portion; and the camera or ocular is located near the opening portion so as to receive the light coming from the condenser.

(15) A reflecting telescope as mentioned in (14) above, characterized in that the angle of the light so reflected by the concave mirror is predetermined and the concave mirror is fixed to the bottom surface of the telescope body so as to reflect the light with the angle so predetermined.

(16) A reflecting telescope as mentioned in (14) above. characterized in that a surface shape of the concave mirror is set to such a shape as to minimize an optical path difference with the condenser and a concave surface shape of the condenser is set arbitrarily.

[0008] In the reflecting telescope of the inventions (14) and (16) above, the condenser is provided outside of the opening portion which is formed in the middle portion of the side wall of the telescope body. Thus, the light entering the upper portion of the telescope body is not blocked by the condenser and the full quantity of the light so entering is reflected by the concave mirror. The angle of the reflected light is adjusted by the concave mirror being moved by driving the actuator and the angle is so set that the full quantity of the reflected light passes through the opening portion to be received by the condenser. Thus, the full quantity of the light entering the upper portion of the telescope body is reflected by the concave mirror and received by the condenser to be further received by the camera or ocular right below the condenser and there occurs no reduction in the light converging ability.

[0009] In the invention (15) above, the angle of the light reflected by the concave mirror is adjusted to be predetermined so that the full quantity of the reflected light may pass through the opening portion of the side wall of the telescope body and the concave mirror is fixed to the bottom surface of the telescope body so as to reflect the light with the angle so predetermined. Hence, when the telescope is directed correctly to the observation object, the full quantity of the light entering the upper portion of the telescope body can be received by the condenser, and thus the actuator can be eliminated and the work for the adjustment of the concave mirror can be saved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Fig. 1 is a perspective constructional view of a space telescope of a first embodiment according to the present invention.

[0011] Fig. 2 is a perspective constructional view of a space telescope of a second embodiment according to the present invention.

[0012] Fig. 3 is a perspective constructional view of a space telescope of a third embodiment according to the present invention.

[0013] Fig. 4 is a constructional view of a space telescope of a fourth embodiment according to the present invention, wherein Fig. 4(a) is a side view and Fig. 4(b) is a view seen from arrows A-A of Fig. 4(a).

[0014] Fig. 5 is a detailed view of a reflecting mirror portion of the telescope of Fig. 4, wherein Fig. 5(a) is a side view and Fig. 5(b) is a plan view.

[0015] Fig. 6 is a view showing one variation example of a counter weight of the telescope of Fig. 4, wherein Fig. 6(a) is a side view and Fig. 6(b) is a plan view.

[0016] Fig. 7 is a side view showing another variation example of the counter weight of the telescope of Fig. 4.

[0017] Fig. 8 is an explanatory view of operation examples of the counter weight of Fig. 5, wherein Fig. 8(a) is an example using a pulley and Fig. 8(b) is an example using an actuator.

[0018] Fig. 9 is an explanatory view of application examples of the counter weight of Fig. 8 which are added with horizontal component counter weights, wherein Fig. 9(a) is an example using a rope and Fig. 9(b) is an example using an actuator.

[0019] Fig. 10 is a constructional view of a space telescope of a fifth embodiment according to the present invention, wherein Fig. 10(a) is a side view and Fig. 10 (b) is a view seen from arrows B-B of Fig. 10(a).

[0020] Fig. 11 is a cross sectional view of an example where an equipment movement control device of a sixth embodiment according to the present invention is applied to a telescope.

[0021] Fig. 12 is a view seen from arrows A-A of Fig. 11.

[0022] Fig. 13 is a detailed cross sectional view of a base stand of the sixth embodiment of Fig. 11.

[0023] Fig. 14 is a view explaining functions of a telescope of the sixth embodiment of Fig. 11, wherein Fig. 14(a) shows a state where the telescope is in a central position and Figs. 14(b) to (e) show states where the telescope is biased to various positions.

[0024] Fig. 15 is a control diagram of the telescope of the sixth embodiment of Fig. 11.

[0025] Fig. 16 is a cross sectional view showing an equipment movement control device of a seventh embodiment according to the present invention, wherein the equipment movement control device is applied to an antenna.

[0026] Fig. 17 is a cross sectional constructional view of an astronomical reflecting telescope of an eighth embodiment according to the present invention.

[0027] Fig. 18 is a cross sectional plan view taken on line A-A of Fig. 17.

[0028] Fig. 19 is a cross sectional view of an astronomical reflecting telescope of a ninth embodiment according to the present invention.

[0029] Fig. 20 is a cross sectional constructional view of a reflecting telescope in the prior art.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0030] Herebelow, embodiments according to the present invention will be described concretely with reference to figures.

[0031] Fig. 1 is a perspective constructional view of a space telescope of a first embodiment according to the present invention. There, numeral 1 designates a telescope body of a cylindrical shape, in which a reflecting mirror, a condenser, a camera and the like are provided, although not illustrated. Numerals 2a, 2b designate telescope body supports, respectively. Each of the telescope body supports 2a, 2b has its one end provided with a shaft 3 for supporting the telescope body 1 rotatably around the shaft 3 and the other end fixed to a basement 4 for supporting the telescope body 1 on the basement 4.

[0032] A shaft 9 has its both ends fixed with counter weight units 5a, 5b (illustration of the unit 5b being omitted) and the counter weight units 5a, 5b together with the shaft 9 are supported rotatably by the shaft 3 on both sides of the telescope body 1. Each of the counter weight units 5a, 5b comprises therein an arbitrary number of sets of counter weights 6a, 6b arranged circumferentially and oppositely to each other. Also, around the basement 4, there is provided rotatably another counter weight unit 7 of a doughnut shape. The counter weight unit 7 comprises therein an arbitrary number of sets of counter weights 8a, 8b arranged circumferentially and oppositely to each other, so that the counter weight unit 7 together with the counter weights 8a, 8b can rotate around the basement 4. Numeral 10 designates a rotator drive for controlling rotation of the counter weights 6a, 6b.

[0033] The telescope constructed as mentioned above is rotatable around a vertical axis Y along a central axis of the basement 4 and around a horizontal axis X along a central axis of the shaft 3, respectively, so as to change its attitude toward an object in the space. When the telescope body 1, having a heavier front, or distal, end and a lighter rear, or proximal, end, is moved around the axis X and axis Y to be directed to the object, it sways at the front end to cause a large inertia force. This inertia force acts on the space station on which the telescope is installed to give large influences on the attitude of the space station. Hence, such inertia force must be avoided.

[0034] In the present first embodiment, when the telescope body 1 is rotated around the axis X, to a direction α_1 as shown in Fig. 1 for example, the rotator drive 10 at the same time rotates the counter weights 6a, 6b rapidly to a direction α_2. which is reverse to the direction α_1, so that the inertia force generated is canceled. As the counter weights 6a, 6b are provided in the arbitrary number of sets arranged circumferentially and oppositely to each other, as mentioned above, when they are rotated reversely in a high speed, a force acting in the direction to cancel the inertia force of the telescope body 1 can be obtained.

[0035] Size of the inertia force being able to be adjusted by rotation of the counter weights 6a, 6b, all the inertia forces caused by the rotation of the telescope body 1 around the axis X can be canceled.

[0036] As for the rotation of the counter weights 6a, 6b, although not shown, there may be a construction to rotate them concentrically with the shaft 3 and independent of the telescope body 1 and this construction is, for example, such that a motor included in the rotator drive 10 rotates the shaft 9 to which the counter weights 6a, 6b are fixed or a disc containing the counter weights 6a, 6b circumferentially is rotated by the principle of a linear motor. Control of such rotation of the counter weights 6a, 6b may be done easily by detecting the rotational speed of the telescope body 1 and controlling the rotation of the motor to correspond to the detected speed.

[0037] With respect to the rotation of the telescope body 1 around the axis Y also, when the telescope body 1 together with the basement 4 rotates to a direction β_1 as shown in Fig. 1, for example, the counter weights 8a, 8b are rotated to a direction β_2, which is reverse to the direction β_1, so that inertia force which is caused by the rotation to the direction β_1 to act on the installation basement or on the space station side can be canceled. As the counter weights 8a, 8b are provided in the counter weight unit 7 in the arbitrary number of sets arranged circumferentially and oppositely to each other, as mentioned above, when they are rotated reversely to the telescope body 1, inertia force acting in the direction to cancel the inertia force of the telescope body 1 can be obtained. Also, construction using the principle of a linear motor, as mentioned above, may be applied to the rotation of the counter weights 8a, 8b.

[0038] Thus, if the above described space telescope is installed on the space station, it may be operated with no inertia force being caused, or even if it is installed on land, attitude control thereof may be done easily.

[0039] Fig. 2 is a perspective constructional view of a space telescope of a second embodiment according to the present invention. In Fig. 2, parts or components designated by numerals 1 to 4, 7 and 8 are same as those shown in Fig. 1 with repeated description thereon being omitted and featured portions of the present second embodiment, which are parts or components designated by numerals 11 to 15, will be described below.

[0040] In Fig. 2, the telescope body 1 is supported by the shaft 3 rotatably therearound and an arm drive 14 for rotating arms independent of the telescope body 1 is connected to the shaft 3. A connecting shaft 15 has its both ends fixed with central portions of arms 11a, 11b and this connecting shaft 15 is connected to the arm drive 14. The arms 11a, 11b are constructed such that the arms 11a, 11b have their both ends fitted with counter weights 12a, 12b and 13a, 13b, respectively, and are formed integrally with the connecting shaft 15 to be ro-

tated by the arm drive 14 around the axis X. Other portions of the construction are same as those of the first embodiment shown in Fig. 1.

[0041] In the telescope of the present second embodiment constructed as above, when the telescope body 1 is rotated around the axis X, to direction α_1 for example, the arm drive 14 rotates the connecting shaft 15 together with the arms 11a, 11b to direction α_2, which is reverse to the direction α_1. The arm drive 14 has a function to detect the rotational speed and rotational angle of the telescope body 1 and the arms 11a, 11b are controlled so as to be set to correspond to the speed and angle so detected. Thus, inertia force caused by the rotation of the telescope body 1 around the axis X is canceled by the force acting in the reverse direction and there occurs no case where the inertia force generated is transmitted to the installation side on which the telescope is installed, such as a space station. Also, the inertia force caused by the rotation of the telescope body 1 around the axis Y is canceled by the force caused by the reverse rotation of the counter weights 8a, 8b by the same function as described with respect to the first embodiment shown in Fig. 1.

[0042] Fig. 3 is a perspective constructional view of a space telescope of a third embodiment according to the present invention. In Fig. 3, what is a featured portion of the present third embodiment is a construction that lower portions of the arms 11a, 11b shown in Fig. 2 are cut off and also the counter weights 12b, 13b of the lower ends are eliminated. Other portions are same as those of the second embodiment of Fig. 2.

[0043] In the present third embodiment, arms 21a, 21b provided on both sides of the telescope body 1 are formed integrally with the connecting shaft 15 and are rotated by the arm drive 14 to a direction α_2, which is reverse to a direction α_1 of the rotation of the telescope body 1. Thereby, the inertia force of the telescope body 1 around the axis X is canceled, like in the case of the second embodiment of Fig. 2. As compared with the construction of Fig. 2, the present third embodiment has an advantage that number of pieces of the counter weights is reduced to thereby simplify the structure of the arms.

[0044] Fig. 4 is a constructional view of a space telescope of a fourth embodiment according to the present invention, wherein Fig. 4(a) is a side view and Fig. 4(b) is a view seen from arrows A-A of Fig. 4(a). In Fig. 4, numeral 30 designates a basement. Above the basement 30, there is provided a reflecting mirror 31 with a plurality of actuators 36 being interposed between the basement 30 and the reflecting mirror 31. Numeral 37 designates a counter weight and a plurality of pieces of the counter weight 37 are suspended from circumferential periphery of the reflecting mirror 31. Numeral 32 designates a condenser, which is supported by three pieces of a condenser supporting member 35 standing up from the circumferential periphery of the reflecting mirror 31. Numeral 33 designates a camera. which is supported by a camera supporting member 34 right below the condenser 32.

[0045] Fig. 5 is a detailed view showing the portion of the reflecting mirror 31, the actuators 36 and the counter weights 37 of the fourth embodiment of Fig. 4, wherein Fig. 5(a) is a side view and Fig. 5(b) is a plan view. The plurality of actuators 36 are provided being arranged on a circumferential peripheral portion of the basement 30, so that the reflecting mirror 31 may be moved by drive of the actuators 36 in a given direction for tracking stars and the like. The counter weights 37 are constructed to be driven to move up and down and when a peripheral portion of the reflecting mirror 31 is moved up and down by the actuators 36, the counter weights 37 of that portion are driven to move up and down reversely to the movement of the reflecting mirror 31, so that inertia force caused by the movement of the structural portions of the reflecting mirror 31 and of the condenser 32 and the camera 33 connected to the reflecting mirror 31 may be canceled. In the example shown in Fig. 5, when the right hand side of the reflecting mirror 31 is moved upwardly as shown by numeral 38, the counter weight 37 of that portion is moved downwardly as shown by numeral 38'.

[0046] In the present fourth embodiment as described above, the reflecting mirror 31, the condenser 32 and the camera 33 together with the condenser supporting member 35 and the camera supporting member 34 are supported integrally by the actuators 36 for tracking stars and the like and their inertia force is canceled by the counter weights 37 and thereby the microgravity (μ-G) environment of the space station on which the telescope is installed is prevented from being damaged.

[0047] Fig. 6 is a view showing one variation example of the counter weights 37 of the fourth embodiment of Fig. 4, wherein Fig. 6(a) is a side view and Fig. 6(b) is a plan view. In this example, a plurality of counter weights 37a, each of which is of the same structure as that of the counter weight 37 shown in Fig. 5, are provided standing on the circumferential peripheral portion of the basement 30 and construction of other portions is same as that of the fourth embodiment shown in Fig. 5. In Fig. 6, when a portion of the reflecting mirror 31 is moved upwardly as shown by numeral 38, the counter weights 37a of that portion are moved downwardly as shown by numeral 38' and thereby the inertia force generated is canceled.

[0048] Fig. 7 is a side view showing another variation example of the counter weights 37 of Fig. 5. In the present example, a counter weight 39 is provided within the basement 30 and a plurality of counter weight actuators 40 are interposed between an upper wall of the basement 30 and the counter weight 39. When the right hand side of the reflecting mirror 31 is moved upwardly as shown by numeral 38, the counter weight actuators 40 of that portion are driven at the same time to elongate their strokes with a drive force stronger than that of other counter weight actuators 40, so that the counter weight 39 is moved reversely to the movement of the reflecting

mirror 31, that is, downwardly as shown by numeral 38', and the inertia force generated is canceled.

[0049] Fig. 8 is an explanatory view of operation examples of the counter weight 37 of the fourth embodiment, wherein Fig. 8(a) is of an example using a pulley and Fig. 8(b) is of an example using an actuator. In Fig. 8(a), the counter weight 37 is suspended from a support member 41 and is connected to the reflecting mirror 31 via a pulley 42. By this construction, when the reflecting mirror 31 is moved upwardly by the actuator 36, the counter weight 37 is thereby pulled via the pulley 42, so that mass of the counter weight 37 gives a movement which is reverse to that of the reflecting mirror 31 and the inertia force generated is canceled. In Fig. 8(b), the counter weight 37 is fitted to the reflecting mirror 31 via an actuator 43 and when the reflecting mirror 31 is moved up and down by the actuator 36, the actuator 43 elongates or contracts so as to move the counter weight 37 reversely to the movement of the reflecting mirror 31 and thereby the inertia force generated is canceled.

[0050] Fig. 9 is an explanatory view of application examples of the fourth embodiment comprising a horizontal component counter weight, wherein Fig. 9(a) is a side view of an example based on the construction of Fig. 8 (a) and Fig. 9(b) is a side view of an example based on the construction of Fig. 6.

[0051] In Fig. 9(a), a supporting member 44 is fitted to the basement 30 and a rope or chain 47 is fixed to the supporting member 44 so as to pull a horizontal component counter weight 46 via a supporting roller 45 to which the horizontal component counter weight 46 is connected. The horizontal component counter weight 46 is arranged in plural pieces to act in given directions including X and Y directions or intermediate directions thereof in the horizontal plane. Thus, when the basement 30 is moved, tension by the counter weights 46 is given on the supporting member 44 to act in the direction reverse to that of the force acting on the basement 30 in the horizontal plane and the inertia force generated on the basement 30 in the horizontal plane is canceled.

[0052] In Fig. 9(b), the horizontal component counter weight 46 is fitted to the supporting member 44 via an actuator 48 so that the inertia force of the horizontal component may be canceled. It is to be noted that the counter weight 37a of Fig. 6 is fitted to the basement 30 via an actuator 49 in the embodiment of Fig. 9(b).

[0053] Thus, in the examples of Fig. 9, the inertia force generated by the movement of the integral structure of the reflecting mirror 31, the condenser 32 and the camera 33 is canceled by the counter weight 37a of Fig. 6 or the counter weight 37 of Fig. 8(a) and, in addition to that, the inertia force acting on the basement 30 in the horizontal direction also is canceled by the horizontal component counter weight 46. Hence, the inertia force generated in the space telescope can be offset to be canceled further effectively.

[0054] Fig. 10 is a constructional view of a space telescope of a fifth embodiment according to the present invention, wherein Fig. 10(a) is a side view and Fig. 10 (b) is a view seen from arrows B-B of Fig. 10(a). In Fig. 10, the portions shown by numerals 30 (basement), 31 (reflecting mirror), 36 (actuator) and 37 (counter weight) are of the structure same as that of the fourth embodiment shown in Fig. 4 and when the reflecting mirror 31 is moved, the inertia force caused thereby is canceled as described with respect to Fig. 4.

[0055] In the present fifth embodiment, in addition to the functions of the fourth embodiment, the condenser is designed to be movable. That is, numeral 52 designates a movable condenser, which is movable on a rail 53, or on a movable condenser support 63 in place of the rail 53. The movable condenser 52 is supported by a movable condenser supporting member 62. The movable condenser supporting member 62 is fitted with a wheel 61 and a motor 60 so that the motor 60 rotates the wheel 61 to move the movable condenser 52 on the rail 53. In case the movable condenser 52 is supported by the movable condenser support 63, a plane type linear motor (not shown) is provided on the movable condenser support 63 to move the movable condenser 52 slidably on the movable condenser support 63.

[0056] The rail 53 is made in a pair to be fitted to a rail supporting member 55. The rail supporting member 55 is supported on the basement 30 by three supporting members 54. The movable condenser 52 is fitted with a camera supporting member 34 and a camera 33 is fitted to a lower end of the camera supporting member 34. Thus, the movable condenser 52 and the camera 33 together with the camera supporting member 34 are supported integrally by the movable condenser supporting member 62. While the fourth embodiment shown in Fig. 4 is constructed such that the reflecting mirror 31 and the condenser 32 are moved integrally, the present fifth embodiment is so constructed that the reflecting mirror 31 and a unit of the condenser 52 and the camera 33 are moved independently of each other. Hence, either of them may be moved for tracking stars and the like and the point therefor is that optical axes of both of them are to match with each other finally.

[0057] In the fifth embodiment mentioned above, when the movable condenser 52 is to be moved, the motor 60 is driven to rotate the wheel 61 on the rail 53 and thereby the movable condenser supporting member 62 together with the movable condenser 52 and the camera 33 are moved so as to track stars and the like. If the reflecting mirror 31 is to be moved, it is possible to move it by driving the actuators 36. But, in this case, as the reflecting mirror 31 is large as compared with the condenser 52 to cause a larger inertia force, this inertia force is to be canceled by the counter weights 37, like in the fourth embodiment. It is to be noted that in case the rail supporting member 55 and the rail 53 are used with no linear motor being used, the rail supporting member 55 together with the rail 53 is rotated in the horizontal plane, like rotation α in Fig. 10(b) and thereby the movable condenser 52 is made operable at any giv-

en position needed.

[0058] Fig. 11 is a cross sectional view of an example where an equipment movement control device of a sixth embodiment according to the present invention is applied to a telescope. In Fig. 11, the telescope comprises a telescope body 101 on a moving side and a base stand 120 on a stationary side and is constructed such that the telescope body 101 is movable freely on an upper surface of the base stand 120.

[0059] That is, in Fig. 11, numeral 101 designates the telescope body and numeral 102 designates a condenser. which is supported in an upper central portion of the telescope body 101 by a condenser supporting member 105. Numeral 103 designates a camera, which is supported right below the condenser 102 by a camera supporting member 104 fitted to a periphery of the condenser 102. Numeral 106 designates a reflecting mirror, which reflects light or ray coming from the space to be observed to converge it onto the condenser 102 provided above the reflecting mirror 106. Numeral 107 designates a plurality of telescope body supporting members, which are fixed to a telescope body basement 108 to support a bottom surface of the telescope body 101.

[0060] The telescope body basement 108 constitutes a bottom portion of the telescope body 101 and has a downwardly convex and smoothly curved bottom surface. The telescope body basement 108 has its bottom surface attached with a magnetic substance, such as a permanent magnet, so that the telescope body 101 may be magnetically levitated movably on a concave upper surface 121 of the base stand 120, as described later. The concave upper surface 121 of the base stand 120 is made in a smoothly curved complementary form to maintain a predetermined small gap between itself and the convex bottom surface of the telescope body basement 108. The base stand 120 has a plurality of linear motor stationary side coils 112 attached to an entire portion of the concave upper surface 121 of the base stand 120 so that the telescope body basement 108 may be levitated movably on the concave upper surface 121 with the predetermined small gap being maintained therefrom.

[0061] Further, on the concave upper surface 121 of the base stand 120, there are attached a plurality of moving purpose linear motor coils 110 along radial directions extending from a center of the concave upper surface 121 so that movement of the telescope body basement 108 to a given position on the concave upper surface 121 may be controlled. Also, in the base stand 120 below the concave upper surface 121, there is provided a counter weight moving space 122, which has a predetermined height of the space and is formed in a shape complementary with the concave upper surface 121. A counter weight 130, having its lower surface made of a magnetic substance, is placed movably in the counter weight moving space 122. The counter weight moving space 122 has its bottom surface attached with a plurality of counter weight linear motor stationary side coils 123 and a plurality of counter weight moving purpose linear motor coils 124. It is to be noted that the arrangements of the counter weight linear motor stationary side coils 123 and the counter weight moving purpose linear motor coils 124 on the bottom surface of the counter weight moving space 122 are substantially same as those of the linear motor stationary side coils 112 and the moving purpose linear motor coils 110 on the concave upper surface 121 of the base stand 120 and illustration thereof is omitted.

[0062] Fig. 12 is a view seen from arrows A-A of Fig. 11. On the concave upper surface 121 of the base stand 120, the linear motor stationary side coils 112 are arranged in a mesh state and the moving purpose linear motor coils 110 are arranged along the radial directions extending from the center of the concave upper surface 121. In the example illustrated, the radial directions are eight directions and if they are more than eight, a finer control will be possible. The telescope body 101, as illustrated, is biassed toward the left hand side from the center in Fig. 12 and, in this state, the reflecting mirror 106, the condenser 102 and the camera 103 are integrally moved so as to be directed to the space to be observed. At this time, the counter weight 130 is biassed reversely to the telescope body 101, that is, toward the right hand side in the figure, and thereby the inertia force caused by the movement of the telescope body 101 is canceled.

[0063] Fig. 13 is a detailed cross sectional view of a base stand portion of Fig. 11. The telescope body basement 108 is magnetically levitated by the repulsive force between the magnetic substance 111 and the linear motor stationary side coils 112 with a gap t being maintained therebetween and is biassed to the left hand side by the action of the moving purpose linear motor coils 110. On the other hand, the counter weight 130 is likewise magnetically levitated in the counter weight moving space 122 by the repulsive force with the counter weight linear motor stationary side coils 123 and is biassed to the right hand side, which is reverse to the movement of the telescope body basement 108, by the action of the counter weigt moving purpose linear motor coils 124. All of the mentioned movements of the telescope body basement 108 and the counter weight 130 are done synchronously and thereby the inertia force generated can be canceled.

[0064] Fig. 14, in its (a) to (e), shows functions of the telescope body 101 and the counter weight 130 of the telescope of the sixth embodiment of Fig. 11. The functions will be described referring to Fig. 14 as well as Figs. 11 and 12. Firstly, in Fig. 14(a), the telescope body 101a and the counter weight 130 are both in the initial state where they are located at the center of the eight pieces of the moving purpose linear motor coils 110. In this state, when the linear motor stationary side coils 112 attached to the entire concave upper surface 121 are excited, the telescope body 101 is levitated by the repulsive force between the magnetic substance 111 at-

tached to the bottom surface of the telescope body basement 108 and the linear motor stationary side coils 112. In this case, it is to be noted that the linear motor stationary side coils 112 are excited to have the same polarity as the magnetic substance 111 so that the repulsive force may be generated between them.

[0065] In Fig. 14(b), in the state where the telescope body 101 is so levitated, if the portion of the moving purpose linear motor coils 110, shown by bold solid lines in the figure, out of the eight pieces thereof is excited, the telescope body 101b is moved to the left hand side, as illustrated, by the attractive force between that portion of the moving purpose linear motor coils 110 and the magnetic substance 111 attached to the bottom surface of the telescope body basement 108. In this case, the portion of the moving purpose linear motor coils 110, shown by fine lines in the figure, is not excited and the moving purpose linear motor coils shown by the bold solid lines are excited to have such a polarity as to generate the attractive force with the magnetic substance 111 attached to the bottom surface of the telescope body basement 108.

[0066] At this time, the counter weight 130 is likewise levitated by the counter weight linear motor stationary side coils 123 in the counter weight moving space 122 and is moved to the right hand side by the counter weight moving purpose linear motor coils 124. All the mentioned movements of the telescope body 101b and the counter weight 130 are done at the same time and thereby the inertia force caused by the movement of the telescope body 101b is canceled.

[0067] In Fig. 14(c), three moving purpose linear motor coils on the right hand side, shown by the bold solid lines, out of the eight pieces thereof are excited so that the telescope body 101c is moved to the right hand side and the counter weight 130 is moved to the left hand side reversely and thereby the inertia force caused by the movement of the telescope body 101c is canceled.

[0068] Also, in Fig. 14(d), three moving purpose linear motor coils on the upper side, shown by the bold solid lines, out of the eight pieces thereof are excited so that the telescope body 101d is moved upwardly and the counter weight 130 is moved downwardly reversely. Further, in Fig. 14(e), the telescope body 101e is moved downwardly by the same action and the counter weight is moved upwardly reversely, so that the inertia force generated is canceled.

[0069] As described above, the telescope body 101 can be moved to an arbitrary position to be directed to the object to be observed. Further, the telescope body 101 is moved along the concave upper surface 121 of the base stand 120 and the reflecting mirror 106, the condenser 102 and the camera 103 can be directed integrally to the desired direction. Once the position is decided, excitation of the linear motor stationary side coils 112 on the base stand 120 is released and the telescope body basement 108 at its bottom surface is set on the concave upper surface 121 of the base stand 120 to be fixed there.

[0070] Fig. 15 is a control diagram of the telescope of the sixth embodiment of Fig. 11. When position data of two dimensions of X and Y coordinates of the telescope body 101 are given from a setting unit 141, a control unit 140 excites the linear motor stationary side coils 112 to thereby levitate the telescope body 101 from the base stand 120. Then, the control unit 140 selects moving purpose linear motor coils 110 of the position to which the telescope body 101 is to be moved and excites them to be moved. At the same time, the control unit 140 excites the counter weight linear motor stationary side coils 123 to levitate the counter weight 130 as well as selects the counter weight moving purpose linear motor coils 124 of the position which is reverse and symmetrical to the position of the telescope body 101 and excites them to thereby move the counter weight 130 to the reverse direction. By so effecting the control, when the telescope body 101 comes to the position, excitation of the linear motor stationary side coils 112 is released upon signal from the setting unit 141 and the telescope body 101 is fixed on the base stand 120.

[0071] Fig. 16 is a cross sectional view of an example where an equipment movement control device of a seventh embodiment according to the present invention is applied to an antenna. In the seventh embodiment of Fig. 16, an antenna body 150 is used in place of the telescope, shown by reference numerals 101 to 107, of the sixth embodiment of Fig. 11. Construction of the base stand 120 on which the antenna body 150 is installed is same as that shown in Fig. 13.

[0072] In Fig. 16, an antenna body basement 151 of the antenna body 150 constitutes a bottom portion of the antenna body 150 and has a downwardly convex and smoothly curved bottom surface. The antenna body basement 151 has its bottom surface attached with a magnetic substance 152, such as a permanent magnet, so that the antenna body 150 may be magnetically levitated movably on the concave upper surface 121 of the base stand 120.

[0073] That is, the base stand 120, being of the same structure as shown in Fig. 13, has its concave upper surface 121 attached with a linear motor stationary side coils and thereby the antenna body 150 can be magnetically levitated movably on the concave upper surface 121 of the base stand 120 by the same principle as described with respect to the sixth embodiment. The functions thereof being same as those described with respect to Figs. 14 and 15, repeated description will be omitted. In the present seventh embodiment also, the antenna body 150 is magnetically levitated on the base stand 120 and thereby the antenna body 150 can be moved easily to a desired direction and position.

[0074] It is to be noted that although the examples where the telescope is placed on the base stand 120 in the sixth embodiment and the antenna is placed on the base stand 120 in the seventh embodiment have been described, the present invention is not limited thereto

but may be applied to measuring devices, testing devices or the like that have directivity, other than the mentioned examples and in this case also, the same effect can be obtained.

[0075] An astronomical reflecting telescope of an eighth embodiment according to the present invention will be described with reference to Figs. 17 and 18. In Figs. 17 and 18, numeral 201 designates a telescope body, which has an upper portion 201a and a lower portion 201b wherein a transverse cross sectional area of the lower portion 201b is larger than that of the upper portion 201a, an shown in Fig. 18. That is, while a transverse cross section of the upper portion 201a is circular, that of the lower portion 201b is of a circular shape enlarged on one side, on the right hand side in Fig. 18, by an opening portion 206 which opens obliquely upwardly. A bottom portion of the telescope body 201 has a circular shape, like the upper portion 201a. It is to be noted that the opening portion 206 may be formed by cutting out a necessary area in an arbitrary shape.

[0076] Numeral 202 designates a concave mirror, which is arranged on the bottom portion of the telescope body 201. Numeral 203 designates a condenser, which is located, outside of the opening portion 206 away from the central axis of the telescope body 201, at a position from which the concave mirror 202 of the bottom portion of the telescope body 201 is looked over through the opening portion 206. Numeral 204 designates a camera or an ocular, which is located near the opening portion 206 at a position of a convergent point of the light coming from the condenser 203. That is, the condenser 203 and the camera 204 are located in the area near the opening portion 206 away from the central axis of the telescope body 201.

[0077] Numeral 205 designates an actuator, which is arranged in a multiplicity of pieces between the bottom surface of the telescope body 201 and the bottom surface of the concave mirror 202. Thus, by driving the actuators 205 existing near the required position, setting angle of the concave mirror 202 relative to the bottom surface of the telescope body 201 can be changed arbitrarily. Hence, according to the angle of an entering light 210, a reflecting light 210a is reflected toward the condenser 203 to be converged accurately.

[0078] In the present eighth embodiment constructed as above, the light 210 from the space enters the upper portion 201a of the telescope body 201 to be reflected by the concave mirror 202, like numeral 210a, and then to be converged by the condenser 203, like numeral 210b and is focussed to be taken as an image by the camera 204 right below the condenser 203. The angle of the light 210a reflected by the concave mirror 202 is adjusted to be set so as to be converged to the condenser 203 by driving the actuators 205, as mentioned above. According to the present embodiment, the light 210 entering the telescope body 201 from above reaches the concave mirror 202 in its full quantity without being partially blocked on the way by the condenser 203, as in the prior art case, and an accurate image can be taken without reduction in the converging performance.

[0079] It is to be noted that a surface shape of the concave mirror 202 is set to such a shape as to minimize an optical path difference with the condenser 203 and a concave surface shape of the condenser 203 is set arbitrarily.

[0080] Fig. 19 is a cross sectional constructional view of an astronomical reflecting telescope of a ninth embodiment according to the present invention. In the present ninth embodiment, as compared with the eighth embodiment shown in Fig. 17, the actuators 205 are eliminated and constructions of other portions are same as those shown in Fig. 17.

[0081] Accordingly, in the ninth embodiment, the angle of the concave mirror 202 relative to the bottom surface of the telescope body 201 is set in advance so that the reflected light 210a may be converged to the condenser 203 when the telescope body 201 is correctly directed to the observation object, and the concave mirror 202 has its bottom portion fixed to the bottom surface of the telescope body 201 so as to reflect the light with the angle so set. In the present ninth embodiment also, the light 210 entering the upper portion 201a of the telescope body 201 is in no case blocked by the condenser, differently from the prior art case, no converging performance of the telescope is reduced and the same effect as that in the eighth embodiment can be obtained.

[0082] It is to be noted that the reflecting telescope of the present invention is applicable to any usage including an astronomical observation telescope installed on land or mounted on a space craft that flies in the space for a space observation and, in this case also, the same effect can be obtained.

[0083] In the above, while the three kinds of embodiments according to the present invention have been described, combinations of two or more, as the case may be, of the mentioned embodiments may be also employed. For example, it is possible that the counter weights of the first kind embodiment is employed in the reflecting telescope of the third kind embodiment and this is moved by the equipment movement control device of the second kind embodiment.

Claims

1. A telescope comprising a telescope body (1) and a reflecting mirror (31), a condenser (32) and a camera or ocular (33) contained in said telescope body (1), characterized in further comprising a counter weight (6a, 6b, 8a, 8b, 12a, 12b, 13a, 13b) that moves rotationally at the same time when said telescope body (1) is moved rotationally to be directed to an observation object so that inertia force caused by the rotational movement of said telescope body (1) may be canceled.

2. A telescope comprising a telescope body (1) and a reflecting mirror (31), a condenser (32) and a camera or ocular (33) contained in said telescope body (1), characterized in that said reflecting mirror (31), condenser (32) and camera or ocular (33) are connected integrally to one another so that said reflecting mirror (31) is movable together with said condenser (32) and camera or ocular (33) to be directed to an observation object.

3. A telescope comprising a telescope body (1) and a reflecting mirror (31), a condenser (32) and a camera or ocular (33) contained in said telescope body (1), characterized in that said reflecting mirror (31) and a unit of said condenser (32) and camera or ocular (33) are movable independently of each other.

4. A telescope as claimed in Claim 2 or 3, characterized in that a plurality of counter weights (37) are fitted to a circumferential periphery of a bottom portion of said reflecting mirror (31).

5. A telescope as claimed in Claim 2 or 3, characterized in that a plurality of counter weights (37a) are fitted to a circumferential periphery of a base portion (30) to which said reflecting mirror (31) is fitted.

6. A telescope as claimed in Claim 2 or 3, characterized in that a counter weight (37) is provided between said reflecting mirror (31) and a base portion (30) to which said reflecting mirror (31) is fitted so that a bottom surface of said reflecting mirror (31) and said base portion (30) are connected to each other and said counter weight (37) is movable in a direction reverse to a movement of said reflecting mirror (31).

7. A telescope as claimed in Claim 4, characterized in that each of said counter weights (37) is fitted via an actuator (43).

8. A telescope as claimed in Claim 5, characterized in that each of said counter weights (37a) is fitted via an actuator (49).

9. A telescope as claimed in Claim 5, characterized in that a plurality of horizontal component counter weights (46) are arranged on an upper surface of said base portion (30).

10. A telescope as claimed in Claim 6, characterized in that a plurality of horizontal component counter weights (46) are arranged on an upper surface of said base portion (30).

11. A telescope as claimed in Claim 1, characterized in that said counter weight (6a, 6b, 8a, 8b) comprises a counter weight (6a, 6b) for canceling the inertia force caused when an end of said telescope body (1) inclines toward the observation object to move up and down rotationally and a counter weight (8a, 8b) for canceling the inertia force caused when said telescope body (1), so inclining, rotates around an axis orthogonal to a base portion (4) to which said telescope body (1) is fitted.

12. A telescope as claimed in Claim 11, characterized in that said counter weight (12a, 12b, 13a, 13b) for canceling the inertia force caused when said end of the telescope body (1) moves up and down rotationally is fitted to an end of an arm (11a, 11b, 21a, 21b) and said arm (11a, 11b, 21a, 21b) is constructed to be rotatable.

13. An equipment movement control device for moving an equipment body to be directed to an object, characterized in comprising an equipment body (101) having its bottom surface formed in a curved shape; an equipment body basement (108) supporting a bottom portion of said equipment body (101) and having its bottom surface made of a magnetic substance (111) and formed in a curved shape complementary to said curved shape of the bottom surface of the equipment body (101); a base stand (120) having its upper surface (121) formed in a curved shape complementary to said curved shape of the bottom surface of the equipment body basement (108) so that said bottom surface of the equipment body basement (108) may abut on said upper surface (121) of the base stand (120) levitatably therefrom; a plurality of stationary side coils (112) arranged on an entire portion of said upper surface (121) of the base stand (120); a plurality of moving purpose coils (110) arranged in radial directions extending from a center of said upper surface (121) of the base stand (120); and a control means (140) for exciting said stationary side coils (112) and moving purpose coils (110) so as to levitate said equipment body basement (108) from said base stand (120) and to control a movement of said equipment body basement (108).

14. An equipment movement control device as claimed in Claim 13,
characterized in that said equipment body (101) is a telescope body (101) that comprises a reflecting mirror (106) formed in a curved shape on a bottom surface of said telescope body (101), a condenser (102) arranged in an upper portion of said telescope body (101) and a camera or ocular (103) supported right below said condenser (102).

15. An equipment movement control device as claimed in Claim 13,
characterized in that said equipment body (101) is

an antenna body (150) that comprises an antenna erecting at a central portion of said antenna body (150) and has its bottom surface formed in a curved shape.

16. An equipment movement control device as claimed in any one of Claims 13 to 15, characterized in that said base stand (120) has a space (122) formed therein having a curved shape complementary to said curved shape of the upper surface (121) of the base stand (120) and having a constant height of said space (122); a counter weight (130), having its bottom surface made of a magnetic substance, is placed movably in said space (122); a plurality of stationary side coils (123) are arranged on an entire portion of a bottom surface of said space (122); a plurality of moving purpose coils (124) are arranged in radial directions extending from a center of said bottom surface of the space (122); and said control means (140) controls excitement of said stationary side coils (123) and moving purpose coils (124) so that both of the coils (123, 124) may be excited simultaneously to thereby levitate said counter weight (130) from said bottom surface of the space (122) and to move said counter weight (130) to a direction reverse to the movement of said equipment body basement (108).

17. A reflecting telescope comprising a telescope body (201) of a cylindrical shape, a concave mirror (202) arrangement on a bottom surface of said telescope body (201), a condenser (203) arranged above said concave mirror (202) and a camera or ocular (204) arranged below said condenser (203) and being constructed such that light (210) entering an upper portion (210a) of said telescope body (201) is reflected by said concave mirror (202) to be converged to said condenser (203) and further to said camera or ocular (204),
characterized in that said concave mirror (202) is made so as to make an angle of the light (210a) so reflected adjustable by an actuator (205); an opening portion (206) is formed in a middle portion of a side wall of said telescope body (201); said condenser (203) is located outside of said opening portion (206) so that a full quantity of the light (210) so entering said upper portion (201a) of the telescope body (201) may be reflected by said concave mirror (202) and received by said condenser (203) through said opening portion (206); and said camera or ocular (204) is located near said opening portion (206) so as to receive the light coming from said condenser (203).

18. A reflecting telescope as claimed in Claim 17, characterized in that said angle of the light (210a) so reflected by said concave mirror (202) is predetermined and said concave mirror (202) is fixed to said bottom surface of the telescope body (201) so as to reflect the light with said angle so predetermined.

19. A reflecting telescope as claimed in Claim 17, characterized in that a surface shape of said concave mirror (202) is set to such a shape as to minimize an optical path difference with said condenser (203) and a concave surface shape of said condenser (203) is set arbitrarily.

Fig. 1

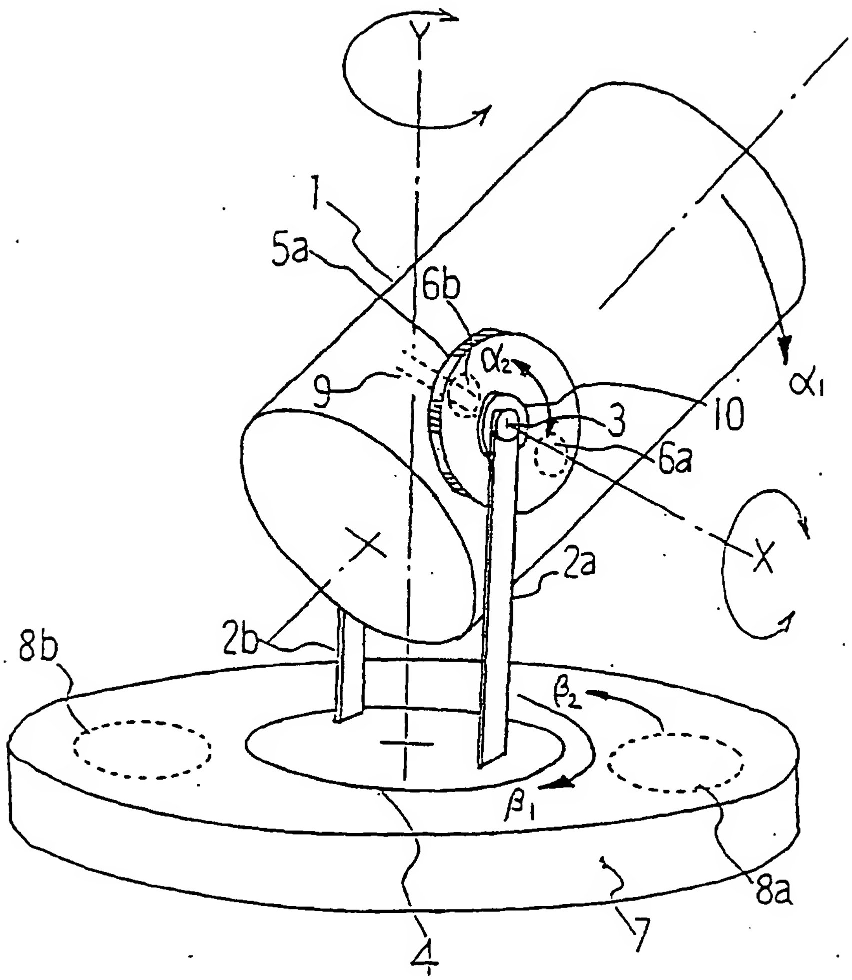


Fig. 2

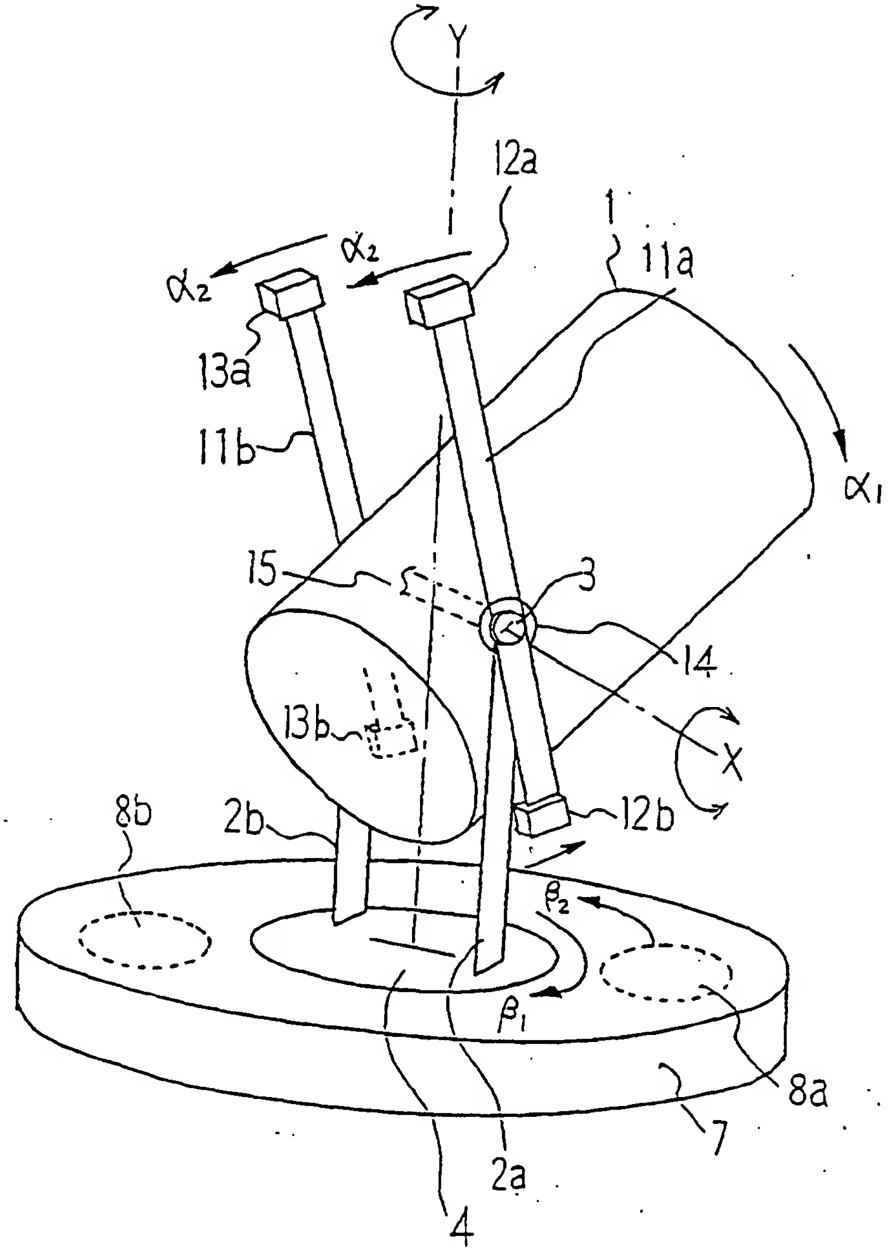

Y
12a
1
11a
α_2
α_2
13a
11b
α_1
15
3
14
13b
X
8b
2b
12b
β_2
β_1
8a
7
2a
4

Fig. 3

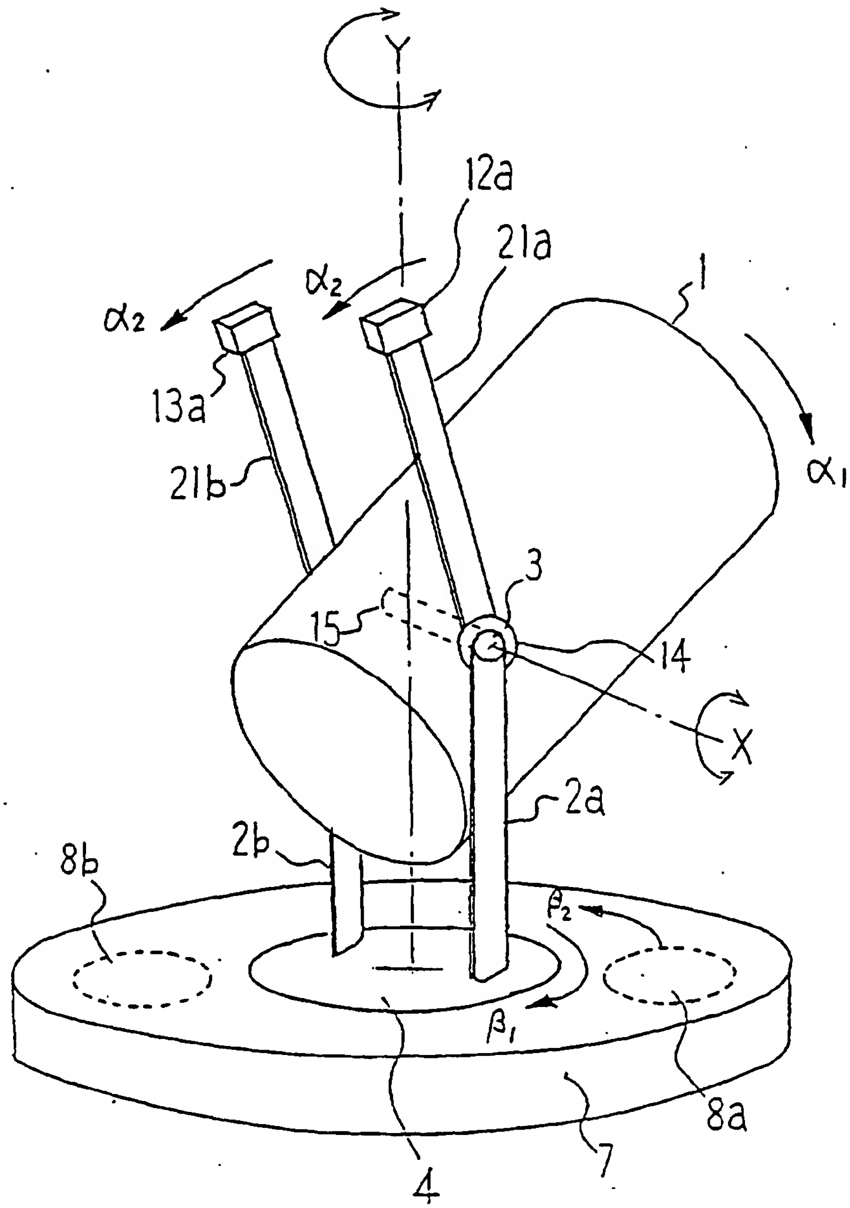


Fig. 4(a)

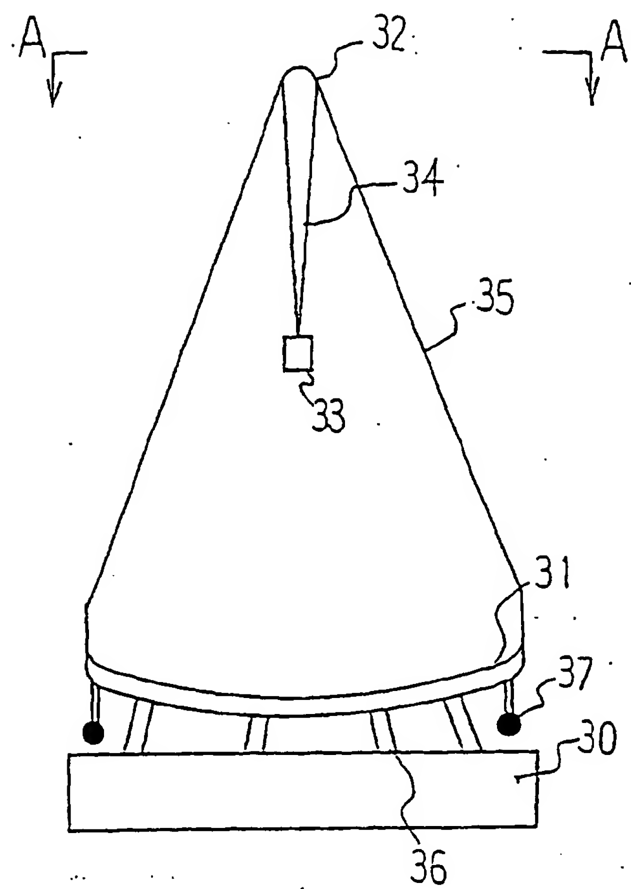


Fig. 4(b)

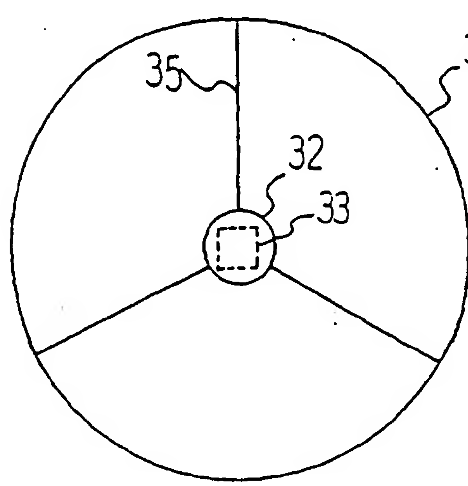


Fig. 5 (a)

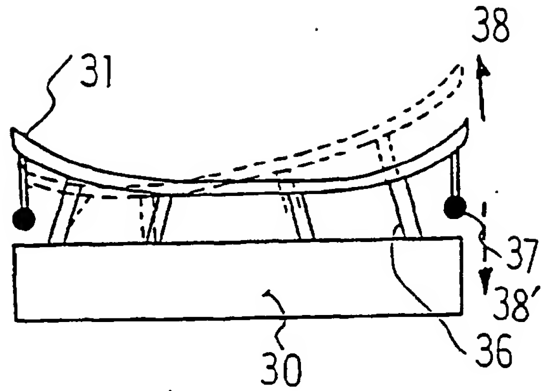


Fig. 5 (b)

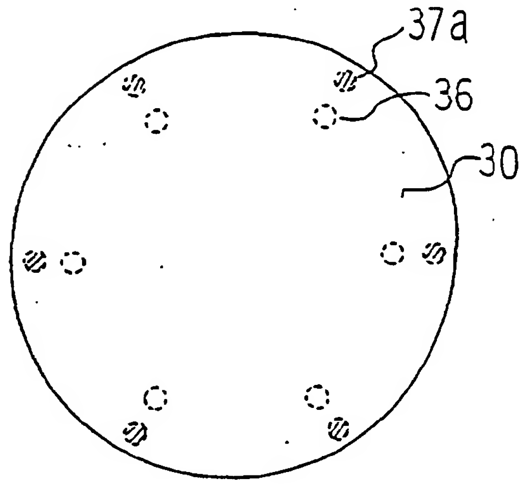


Fig. 6 (a)

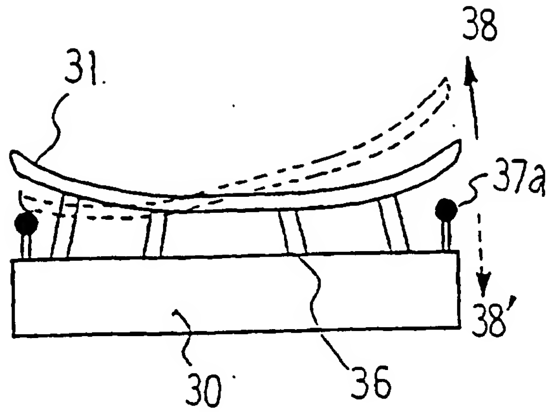


Fig. 6 (b)

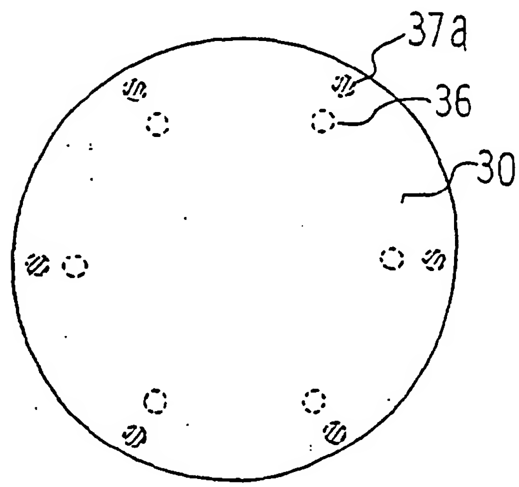


Fig. 7

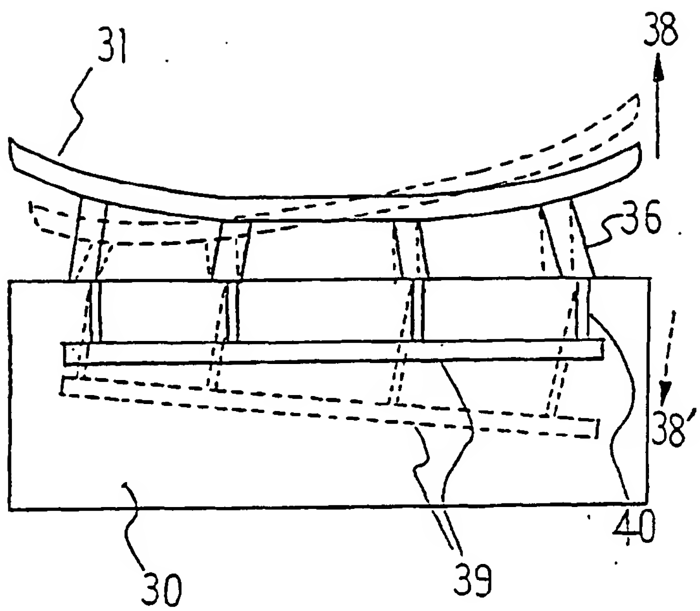


Fig. 8 (a)

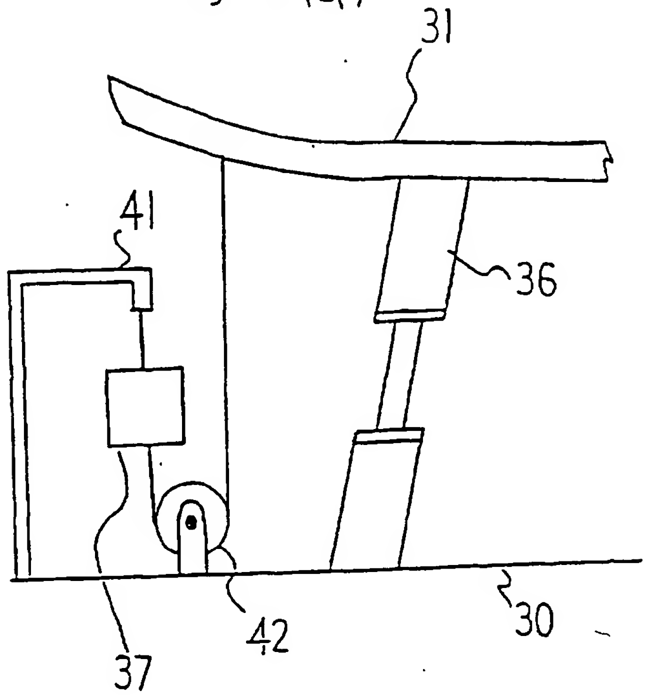


Fig. 8 (b)

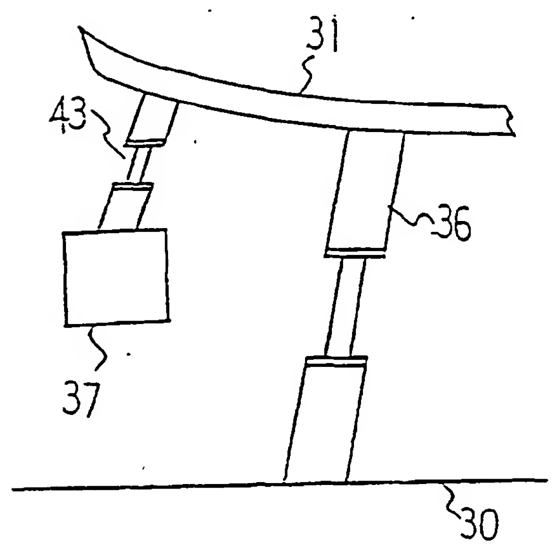


Fig. 9 (a)

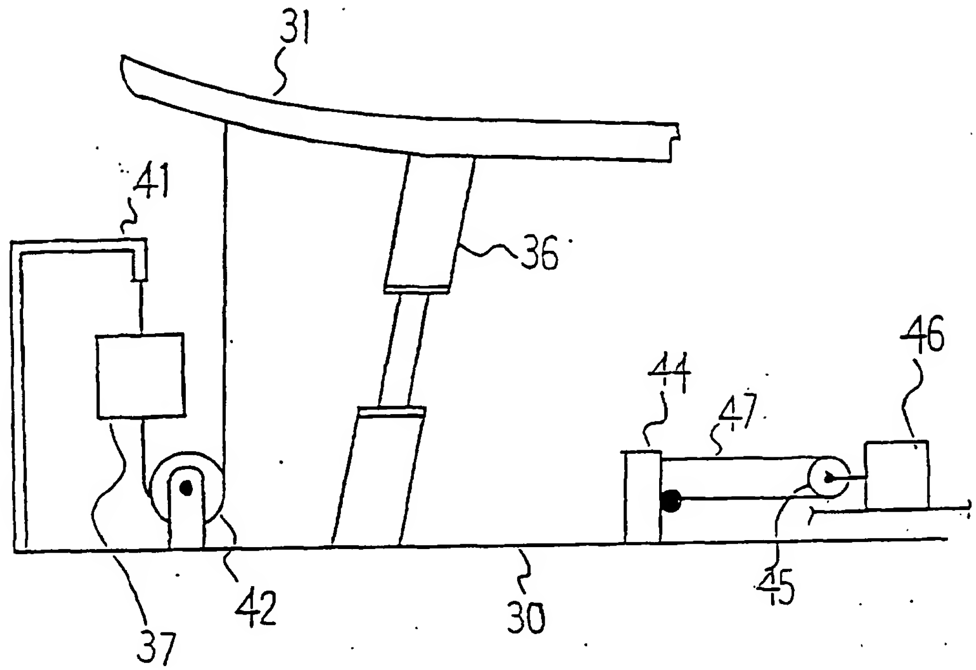


Fig. 9(b)

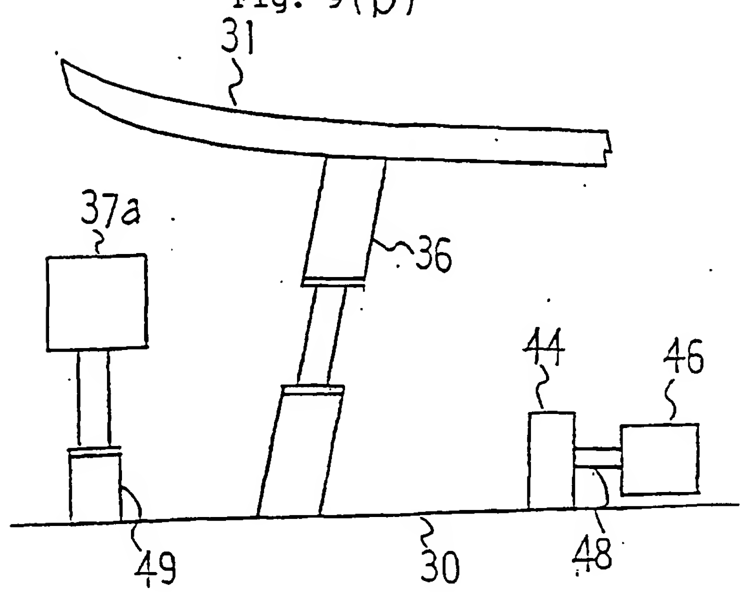


Fig. 10(a)

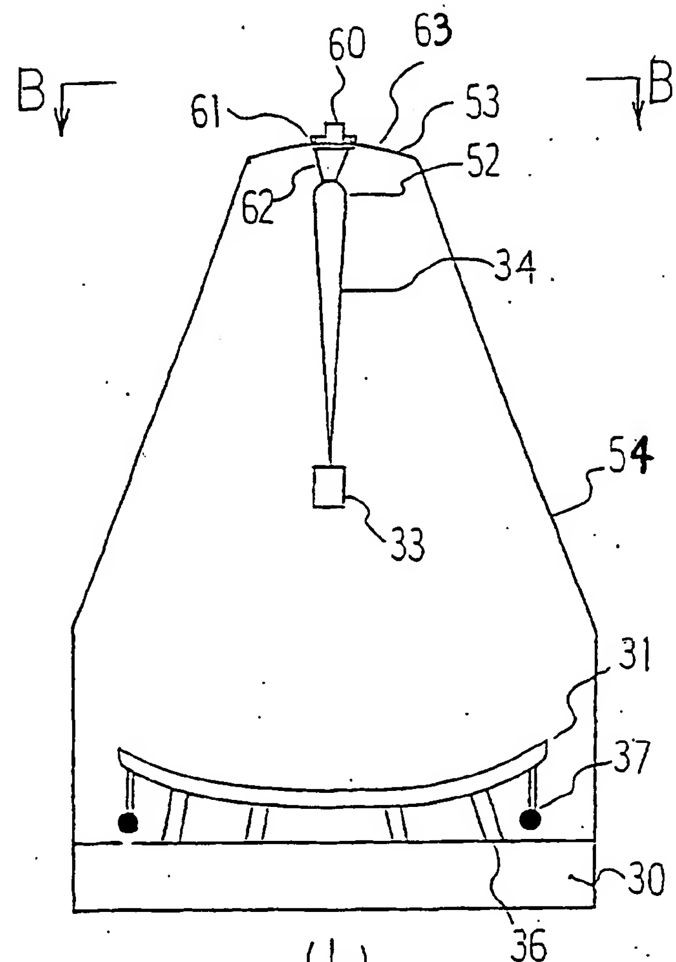


Fig. 10(b)

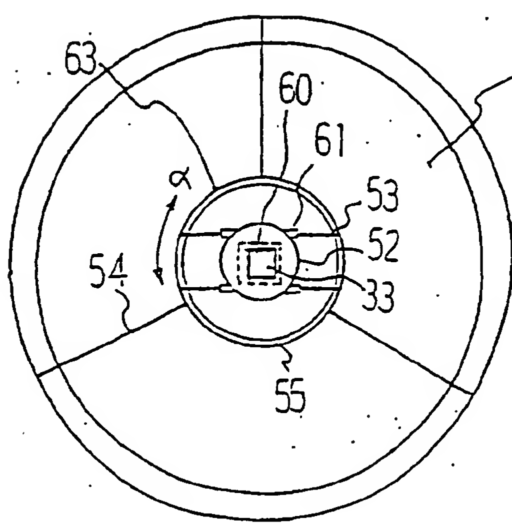


Fig. 11

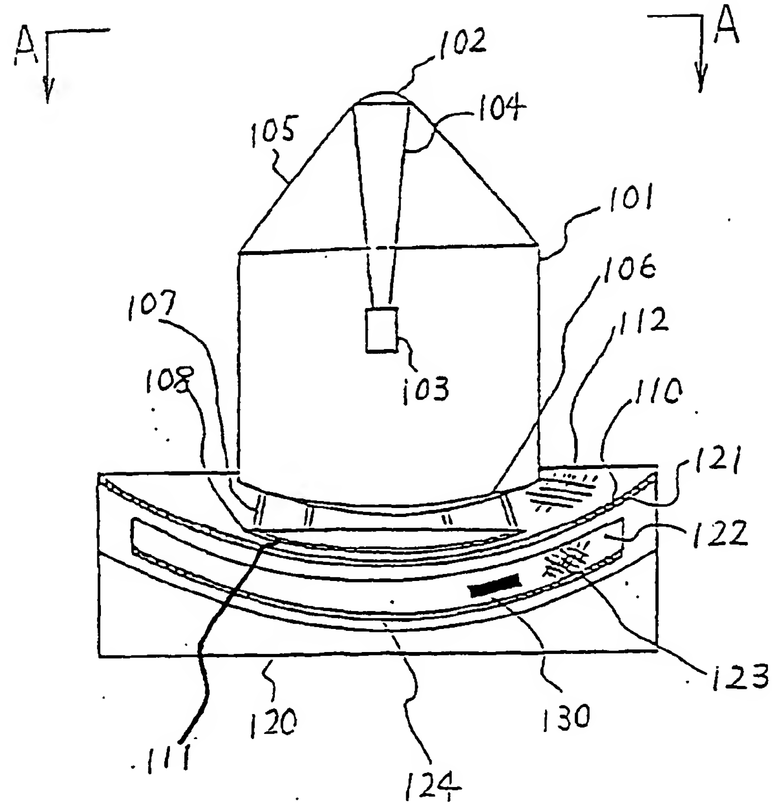

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Fig. 12

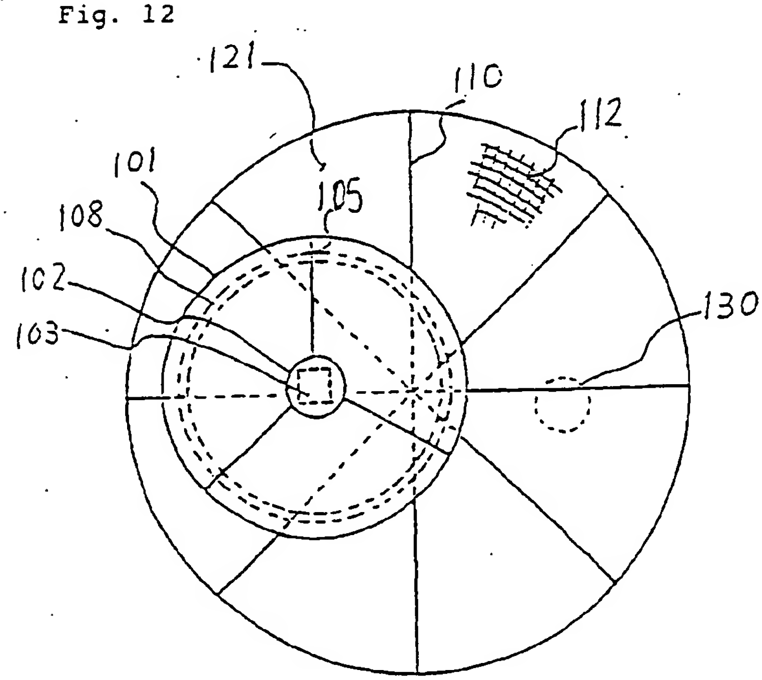
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Fig. 13

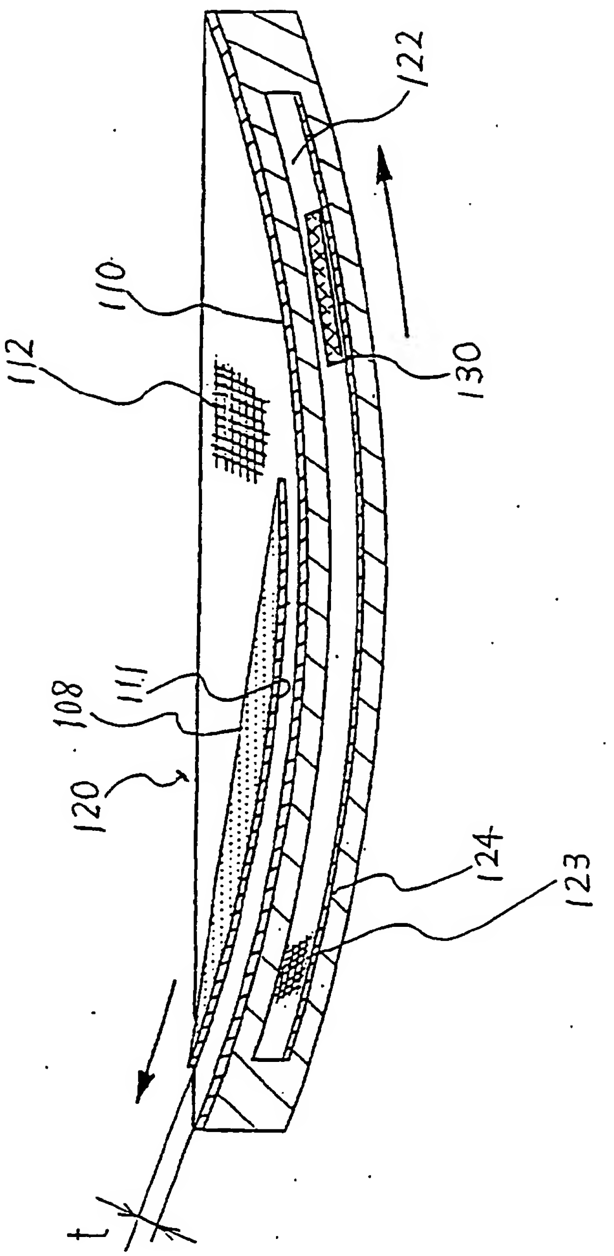

Fig. 14(a)

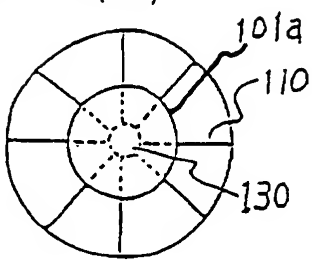

Fig. 14(b)

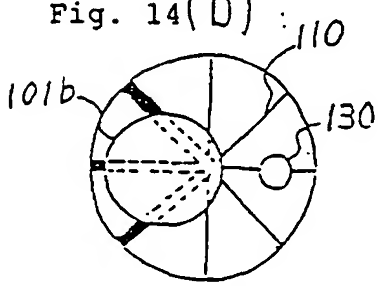

Fig. 14(C)

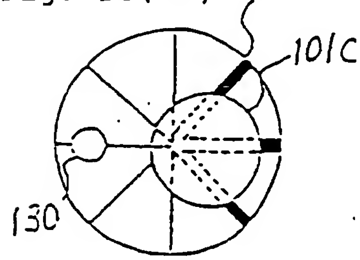

Fig. 14(d)

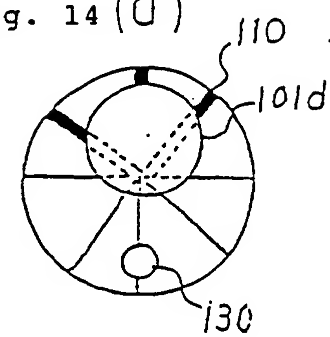

Fig. 14(e)

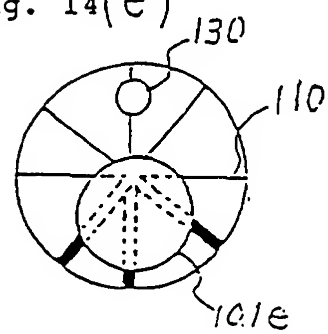

Fig. 15

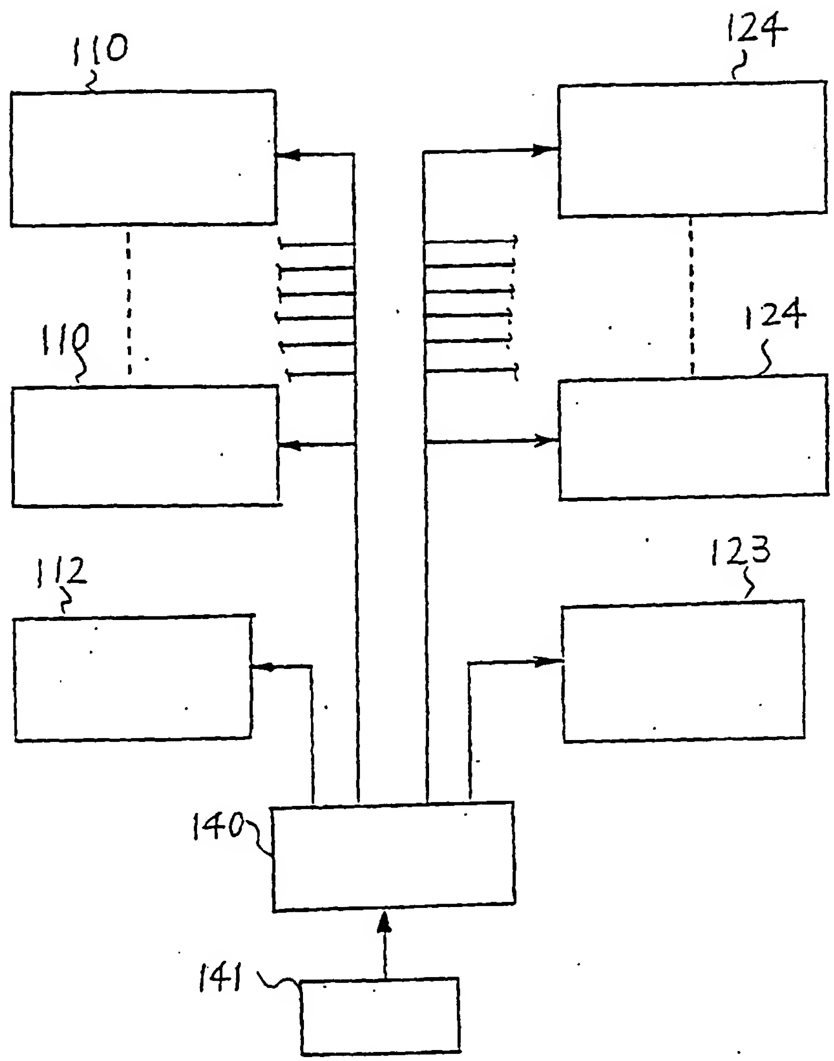

Fig. 16

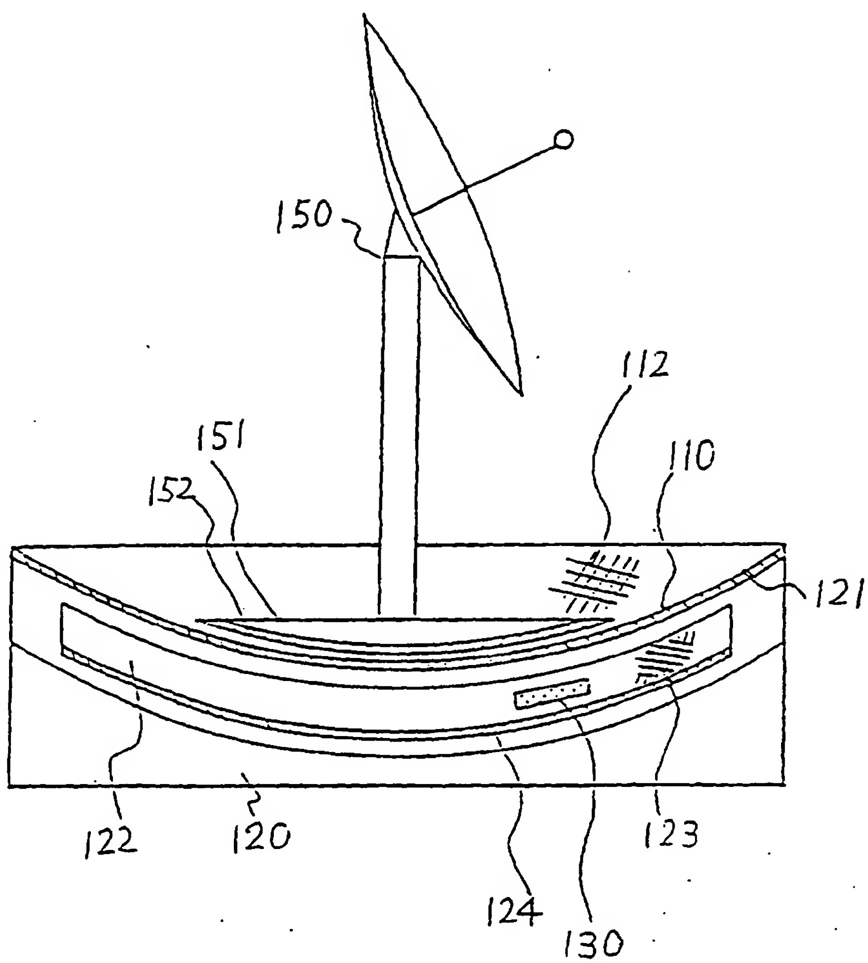

Fig. 17

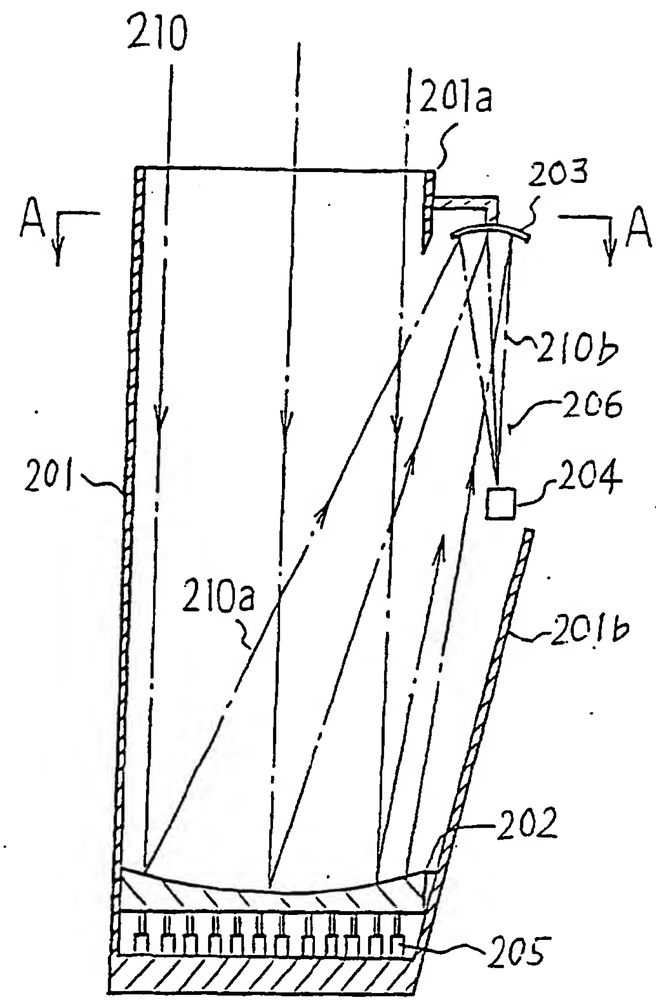
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Fig. 18

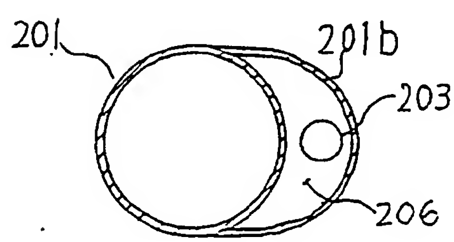
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Fig. 19

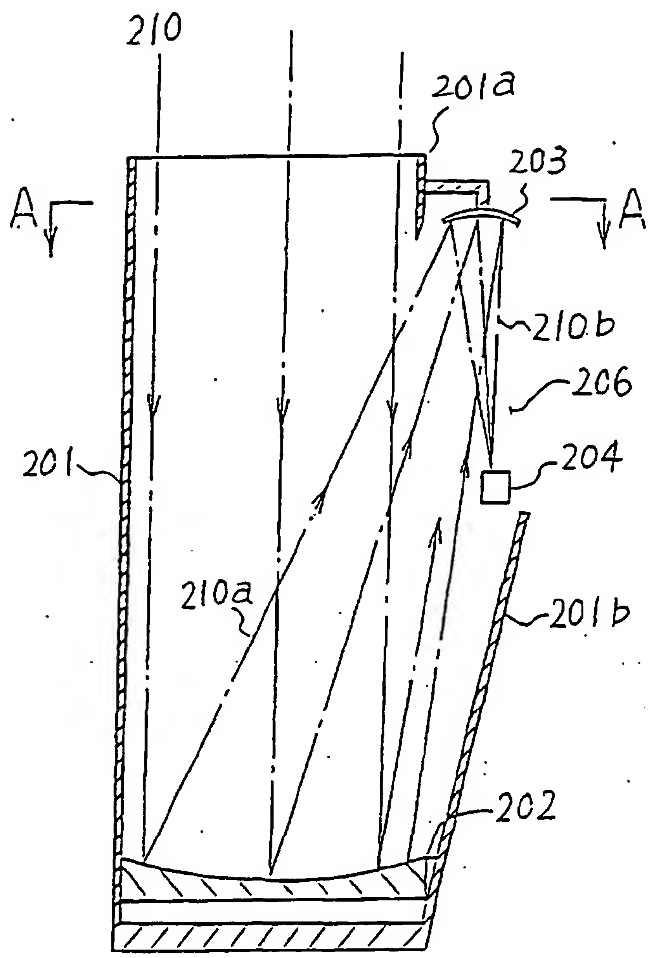
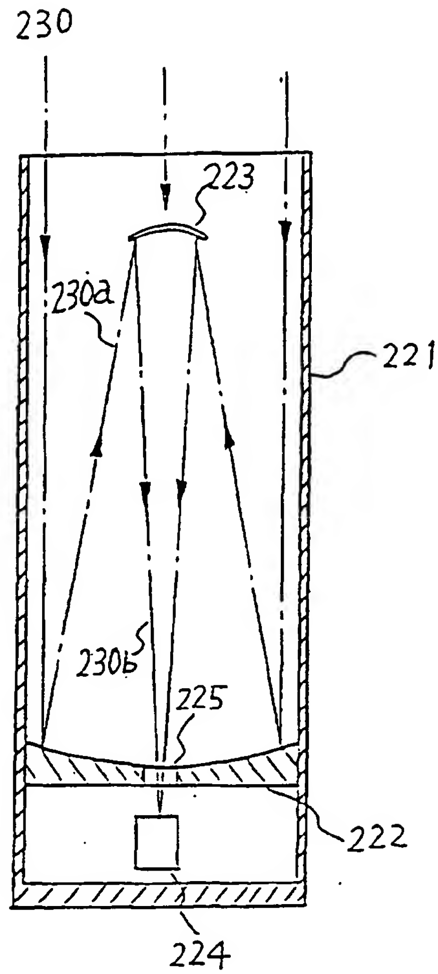


Fig. 20



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP00/01395

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] G02B 23/16 G02B 7/183 B64G 1/66
H01Q 1/12 H01Q 1/28 H01Q 3/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] G02B 23/16 G02B 7/183 B64G 1/66
H01Q 1/12 H01Q 1/28 H01Q 3/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1940-1996 Toroku Jitsuyo Shinan Koho 1994-2000
Kokai Jitsuyo Shinan Koho 1971-2000 Jitsuyo Shinan Toroku Koho 1996-2000

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	US, 5131611, A (The Perkin-Elmer Corporation), 21 July, 1992 (21.07.92), Column 1, lines 10 to 25 (Family: none)	1,2 4-16
Y X	JP, 7-281102, A (Mitsubishi Electric Corporation), 27 October, 1995 (27.10.95), Figs. 7, 8, Fig. 37 (Family: none)	1,2 3
X A	EP, 682126, A (Hughes Aircraft Company), 15 November, 1995 (15.11.95), Column 4, lines 33 to 58; Fig. 1 &JP,8-92767,A	18,19 17

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search
29 May, 2000 (29.05.00)

Date of mailing of the international search report
06.06.00

Name and mailing address of the ISA/
Japanese Patent Office

Facsimile No.

Authorized officer

Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP00/01395

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Claims 1 and 4 to 12 have an object to suppress an inertia force from producing due to operation and relates to a telescope used for operating counterweights.

Claim 2 relates to a telescope comprising a reflecting mirror, a condenser, and a camera or an ocular, and Claim 3 relates to a telescope in which these components are simply made movable independently of each other.

Claims 13 to 16 relate to a telescope moved floatingly by a magnetic force or a movement control device such as an antenna.

Claims 17 to 19 relate to a reflecting telescope so disposed that light incident onto a concave mirror is not shielded by a condenser.

As mentioned above, these four groups of inventions are not considered to constitute a group of inventions capable of achieving the same object and being so limited as to form a single general inventive concept.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest ☐ The additional search fees were accompanied by the applicant's protest.
☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (cotinuation of first sheet) (July 1992)